Should the prize of the centuries be denied to these intrepid voyagers, however, it may be that some devoted enthusiast will be moved to attempt to explore the unknown area in an expedition planned on the lines of the Fram voyage, which after all promises the greatest chance of success.

In such an event it is hoped that the data secured as a result of this drift-cask experiment may be found to be a contribution of some value to the hydrography of the Arctic regions.

BLINDNESS FROM CONGENITAL MALFORMATION OF THE SKULL.

(Plate XX.)

BY CHARLES A. OLIVER, A.M., M.D.

(*Read April 5, 1902.*)

Congenital malformations of the skull assert their evil effects upon the integrity of the tissues of the visual apparatus and its consequent functioning in definite ways. Should the disturbing factors be set into activity during intrauterine existence, while the cranial bones are passing through their primary stages of development, the direct effects of such disturbance will be so great that not only will organic changes appear in the ocular structures, but coarse associated faults will manifest themselves in the related and contiguous tissues.

The posterior portion of the cranium is proportionally the largest during the early stages of development of the skull, the parietal regions beginning to enlarge at about the eighth week of intrauterine life, followed soon afterward by the frontal and the occipital regions.

The newly born cranium is relatively very large in comparison with the rest of the body. In contrast with the facial portion it exhibits a predominance of the cerebral part in proportion of seven to one. The six membranous fontanelles and the fibrous septa between the adjacent osseous structures continue intracranially with the dura mater and extend extracranially to form the pericranium, giving rise to sacs in which bony plates without diploë are situated. At this period of life there are cartilaginous areas scattered through the occipital bone, while the presphenoid portion of the sphenoid

bone fails to exhibit any of the sinuses that are seen in adult life. The optic foramina are large in size and triangular in shape, having been obtained by the confluence of the presphenoidal and orbito-sphenoidal centres. The superciliary ridges and frontal sinuses are not yet present. The lacrymal bones consist of simple delicate sheets. As a rule, the nerve foramina occupy sutural points or positions of ossific centres.

Both the primary and the secondary foramina, particularly the latter, are disturbed by distortion-processes taking place during their passage through many complicated bony tunnels before they escape through the dural sheath, as is primarily done by the former types.

Minor arrests and perversions of development in the bones of the upper face are so frequent that they constitute the daily findings of the scientific ophthalmologist and trained optician. Orbital deformities, more especially those of the rim of the orbit, are very common, and although they have decided effects upon refractive error and exterior-ocular muscle-equilibrium, they fail to exert but little, if any, damage upon combined visual functioning when the resultant functional faults are either orthopedically or radically corrected. More pronounced osseous deformation, the result of disturbances of development of the bones of the face, show coarser signs of fault in the eyeballs and their adnexa; exhibiting, for example, monolateral and bilateral stenoses of the nasolachrymal ducts. In the grosser forms of congenital malformation leading to antenatal or, later, postnatal blindness (the subject-matter of this communication), it is probable that the primary changes have taken place in the notochordal and trabecular regions during the chondral stages of development of the brain-case. In these types, both irregular ossification with consequent cranial contraction in one situation and undue expansion in another, and undue sutural closure from inflammation of the osteophytic membranes with resultant thickenings and ridge-like eminences along the osseous junctures, especially in the basilar series of bones at their asteriorial, inional and lambdal points of junction, may appear.

The normal morphology of the skull is expressed in three stages. The brain vesicles are at first enclosed in a thin delicate sac, a part of which gradually hardens into a fibrous membrane, while the rest persists to form the dura mater of postnatal life. The second stage is represented by a partial conversion of the metamorphic tissues into

cartilage, particularly at the sides and the base of the membranous cranium. During the third stage, true osseous material obtained from both the membrane bones and cartilage bones appears, until finally a more or less completed bony covering containing remnants of chondral matter is obtained.

The occipital bone originates from four centres: the basioccipital, formed from cartilage at about the seventieth day; the two exoccipitals, also derived from cartilage a few days later; and the squamoccipital, composed of two parts, the interparietal and the supraoccipital, which appear from separate nuclei at about the eighty-fourth day, and unite in about twenty-four days' time. At birth all of these parts are connected by cartilaginous strips. They are not fully fused until the seventh year of postnatal life, the two exoccipitals and the squamoccipital becoming ankylosed some two years later.

The sphenoid bone arises from twelve bone nuclei arranged in pairs, these being divided into two pair for the presphenoidal and four for the postsphenoidal centres. These centres successively appear from the fifty-fourth to the ninety-first day of intrauterine life.

The parietal bones are of interest, as they constitute a great portion of the vault and sides of the skull, and are in direct relationship with some of the most important sutures—the sagittal with its fellow, the coronal with the frontal, the lambdoidal with the squamoccipital, and the squamus with the squamal; the anterior inferior angle articulating with the sphenoid, and the posterior inferior angle articulating with the mastoid portion of the petrosal. As a rule, each parietal bone ossifies from a single earthy spot, situated in the outer layer of the membranous covering of the cranium, at about the forty-second day of intrauterine existence.

The frontal bone, another important suture-bearing roof bone, arises from two earthy spots in the external layer of the membranous covering of the cranium, about a week later than those that are intended for the parietal bones. These two portions, as a rule, unite soon after birth by a median suture-line known as the metoptic. Ankylosis commences at about the second year of postnatal existence. A portion of the bone helps form a part of the orbits and has its main connections with the ethmoidal, the lacrymal, the malar, the superior maxillary, the nasal, the parietal, and the sphenoidal bones.

The epipteric bones, wedged between portions of the frontal, the parietals, the sphenoid and the temporal bones, are of importance in this study. They are present from the second year of life to about the age of adolescence; they then persist as true ossicles or help to form new sutures. They are variable in size.

The Wormian bones, that at times are found in great numbers in the various sutures of the cranial part of the skull, must also be considered of value in this connection.

The sphenoid bone, the most important and the most irregular of the basilar bones, is situated in the region of the anterior and middle fossa. It practically contains all of the foramina and fissures intended for the emergence and the exit of the sensory and motor nerves, blood vessels and lymph channels connecting the intracranial and external portions of the visual apparatus. The middle fossa is the most complicated of the three great depressions in the floor of the cranial cavity, it containing all of the most important nerve communications and vascular and lymph channels that are in association with the optic nerves and eyeballs. The posterior fossa hold the occipital lobes in their subdivisional cerebral fossa, that are situated above the groove that is intended for the course of the lateral sinus.

It is a well-known fact that cranial asymmetry is almost universal. Study of the main foramina and fissures of the various orbital cavities of man exhibit marked variabilities in their relative sizes, shapes and positions. The average depth of the orbit of the Negro race, for example, is at least an eighth greater than it is in the orbit of the Caucasian; while the early ossification of the septum with the superior maxilla in the same race produces a normal flattening of the glabella, with a lateral broadening of the alæ of the nose. Moreover, in this class of subjects the characteristic prognathism of the race becomes apparent when the individual has passed the pubertal period, at which time of life an over-development of the inferior maxillary bone occurs. Here there is type-form of individual with a flattened nose, a wide interpupillary distance, a broad, flat forehead and a projecting malar prominence, that are all so characteristic of the usual brachycephalic head: here there are individuals representing one of the principal subspecies of human life in whom there are probable retentions of some of the most pronounced features of the quadrumana; a true acceleration, as it were, passing beyond the Caucasian retardation of embryonic development.

It is not, however, with these minor and relatively undisturbing types that this communication deals. It is with the grosser forms of cranial malformation; those that particularly involve the basilary fossa and their many fissures and foramina; types which sooner or later give expression to blindness as one of their most prominent and characteristic symptoms.

The gross configuration of the skull and the condition of the various portions of the visual apparatus are so strictly in accord with one another, that certain forms of cranial asymmetry can, with almost definite precision, be associated with certain kinds of blindness. Five coarse clinical types of cranial deformation—the well-known oxycephalic, the scaphocephalic, the leptocephalic, the trigonocephalic, and what I have elsewhere described as the occipital or occipito-parietal—may be cited.

The oxycephalic or even the gross hypsicephalic type is characterized by the so-called steeple-shaped or dome-like head. It is dependent upon an improper union of the parietal bones with the occipital bone, the temporal bones and the sphenoid bone, producing compensatory over-developments along the sagittal suture and in the position of the anterior fontanelle. The pterion region with its anterior lateral fontanelle and later Wormian bone, and the region of the lambda marking the situation of the posterior fontanelle, with its intervening sutures and angular articulation, are all too early united and ankylosed, giving rise to corresponding relative disturbances in the calval portion of the cranium, particularly along the sutural lines and in the most nearly related fontanelles.

In this type, which may be very slight or of the grossest character, as shown in the accompanying reproductions of two undeniable cases occurring in my public practice at the Philadelphia and Wills' Hospitals (Plate XX, Figs. 1 and 2), the visual signs of the disease vary from the veriest eye symptom to the coarsest ocular expression, and may first appear at any time during early or middle life.

Case I.—The gross example shown in Fig. 1 was that of a sixty-two-year-old negro, who, with a history of an acute attack of convulsive seizures from fright, occasioned, he asserted, by a fall[1] at one year of age, had three years later the expression of "pop-eyed" epithetically applied to him, this pseudonym having since persisted throughout life.

The patient stated, and I one day had a clinical demonstration of the

[1] The postnatal fall as a causative factor for the cranial malformation must be rejected when the congenital stigmata are considered.

same, that he had more than once pushed his right eye out between the lids. Five years before I saw him he accidentally discovered that he could not see with the left eye. Two and a half years after this the sight of the right eye began to gradually fail, until at the time of examination it was found that vision with it was reduced to a faint doubtful perception of light in an inferior temporal field. The left eye was blind. The superficial areas of the two orbits were immense. The lids were large and the palpebral fissures were broad and long. When the position of the left eye was gauged so as to have its supposed visual axis directed straight ahead, the right eye projected two and a quarter millimeters forward beyond the superior and the inferior margins of the orbit, and diverged some thirty degrees out and three degrees down. When the right eye was placed in the same relative position, the left eye was found to be almost as greatly diverged and was directed somewhat more downward.[1] Curiously, extraocular motion was very little if at all disturbed, although palpation showed that the eyeballs were situated in extremely shallow, almost saucer-like orbits, the shallowest portions of the cavities being situated toward the median line. The corneal epithelium was thickened and the deeper structures of the membrane were opaque in a couple of places. The pupils were large and the irides seemed disproportionately sluggish in their various reactions to the amount of local disturbance. Both lenses presented evidences of dense secondary degeneration, that of the left eye being so opaque that the fundus of the organ was invisible. A faint red glare, with the appearance of a few retinal vessels—best seen with a minus spherical lens of twenty diopters' strength—made it probable that portions of the secondary ocular lesions were due to a high-grade myopia. Intraocular tension in each eye was normal. The anterior scleral vessels were not engorged, and there was not any ciliary tenderness.

The conformation of the skull was typical. The lower jaw, which was increased in size, was mesognathous, if not prognathous in shape. The condition of the hands, as seen crossed upon the body, discredited the belief of any disease of the pituitary body. The bitemporal diameter of the skull was but thirteen and a half centimeters, and the biparietal was but one and a quarter centimeters wider. The occipito-frontal diameter equaled eighteen and a half centimeters, while the occipito-mental was somewhat in excess of twenty-six centimeters. The trachelo-bregmatic diameter was twenty-three and a half centimeters in length.[2]

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[1] The exophthalmus and divergence can be easily differentiated by examination of the reproduction of the photograph of the case.

[2] I am under obligations to Dr. Clarence Van Epps, one of my Residents in both institutions, for presentation of the copy of the photograph of the first subject taken by Mr. James F. Wood, of Philadelphia; to Dr. Frederick C. Krause, one of my former assistants, and now Assistant Ophthalmic Surgeon to

The second example of the type, in a German, an excellent illustration of possibly an extreme hypsicephalic skull with a preternaturally elongated bregmato-mental diameter, is not quite so rare, I having the opportunity to systematically study four or five such patients in a total number of some sixty to seventy thousand cases of ophthalmic disease that I have seen in the combined public and private practice of myself and others.[1]

The reproduction of the photograph of the case shown in Plate XX, Fig. 2 gives a good idea of the general appearances of the head in profile. In this case the suboccipito-bregmatic circumference equaled twenty inches, the occipito-frontal circumference was nineteen and a half inches, and the occipito-mental circumference equaled twenty-six and a half inches.

CASE II.—The patient, who was born in Germany, was a thirty-five-year-old farmer. He stated that he had always had a curiously shaped skull. He had been free from all disease until he was ten years old, at which time he had had a series of spasms. These convulsions were associated with a permanent divergence of the eyes and a persistent indifferent vision which was more pronounced in the left eye. Three weeks before I saw him, he noticed that the sight of his good eye began to fail, this failure being associated at times with deeply seated orbital pains on the same side. His habits, he said, were good, and there were not any signs of gross hereditary or acquired disease. No other members of his family "for three generations back had gone blind." His parents were not blood relations.

Vision with the right eye was reduced to an incorrectible one-eighth of normal in an excentrically placed field, with its fixation-point situated far up and in. Color perception for green, red, blue and yellow was lost. Vision with the left eye was almost gone, there being but one small area of doubtful at times light-perception situated in an extreme temporal field as the last remnant of sensory functioning. Intraocular tension in each eye was normal. The pupil of the left eye, which was round, was about two millimeters larger than the similarly shaped one of the right eye. The right iris responded fairly well to light-stimulus and accommodative efforts, giving rise to rather prompt consensual reactions of the iris of the almost blind left eye during both of these

St. Christopher's Hospital, in Philadelphia, for photographing the second case; to Dr. William L. Zuill, one of the Assistant Surgeons at Wills' Hospital, for the craniometric measurements of the second case; and to Dr. Frank R. Harrison, of East Liverpool, Ohio, for securing the photograph of the third case.

[1] Individuals from two races have been purposely used in the elucidation of this phase of the subject in order to obtain exceptionally broad standpoints of observation.

impulses. The left iris was almost immobile to light-stimulus thrown upon its retina, but responded feebly to forced movement for supposed accommodation, and gave quite prompt consensual reaction to the iris of the less affected organ. Gross downward convergence of the two eyes, by having the patient endeavor to look at his nose tip, rapidly brought the pupillary areas down to one millimeter each in size.

In spite of a left divergence of about thirty degrees out and slightly down, the exterior muscles of the two organs seemed to enjoy good movement. An almost constant lateral nystagmus that increased upon attempts at near fixation was a prominent symptom.

The patient's eye-grounds were characteristic of consecutive atrophy, that of the right eye showing evidences of a recent optic neuritis of postocular type.

Although not hoping for any permanency of result, I gave the patient the benefit of therapeutically driving more blood through the half-starved and degenerating neural tissues of the affected optic nerves. This was done by the internal administration of large and frequently repeated doses of strychnia, resulting in a temporary betterment.[1]

The main disturbances upon the visual apparatus in this case, therefore, which were probably of twofold character—meningitic and mechanical—were mainly exerted upon the optic nerves at the optic foramina. Secondary degeneration changes were only too certain, as later proven by the steady decline of vision in spite of all constitutional treatment that could be conscientiously and judiciously directed against any supposed dyscrasia.

The scaphocephalic type of cranial malformation exhibits a boat-shaped form of deformity of the cranium, with an extremely broad forehead. The deformation is dependent upon a premature union of the sagittal suture between the medial margins of the parietal bones. Here the brunt of the disturbance seems to exert itself upon the median posterior portion of the anterior fossa, the limbus of the lesser wing of the sphenoid bone, and the anterior medial portion of the middle fossa. True optic neuritis with consecutive atrophy; prominent, sightless and divergent eyes; pupils partly dilated, and irides fixed to light-stimulation, are the most prominent eye-symptoms in such cases. Intelligence is but fair, convulsive seizures are not infrequent, and a lethal ending from some ordinarily innocuous disease is most frequently an early event. Rapid and

[1] During a portion of my studies of this case the patient attended the public clinic of my friend, Dr. George C. Harlan, at the Pennsylvania Hospital. Dr. Harlan's findings and results of treatment coincided with my own.

unstable increases of intracranial pressure from ventricular disturbances are frequent, giving rise to repeated optic nerve-head swellings and retinal extravasations.

The head of the leptocephalic type is small. This condition is caused by a too early union of the fronto-sphenoidal suture between the alæ of the frontal and sphenoidal bones. In this type the intracranial distortions, particularly those that affect the foramina and fissures between the body and the greater and lesser wings of the sphenoid bone, bring optic nerve atrophy from previous inflammation, and later palsies of the exterior ocular muscles, into existence very soon after birth.

The trigonocephalic or three-cornered type of cranial deformity, with its small end situated anteriorly, is dependent upon a premature or improper ossification of the frontal and parietal bones along the coronal suture, particularly in the region of the bregma or pterion; or, at times, it may be due to a fault in osseous ankylosis of the combined frontal bones along the metoptic suture-line. Postneuritic atrophy, the principal ocular expression of the disease, occurring quite early in postnatal life, is apt to appear in the gross examples of the type.

The rarely seen occipital or occipito-parietal type of cranial deformity exhibits a flattened curving of the posterior portion of the cranium. The condition seems to be dependent upon either a too early syntosis of the occipital suture, especially at the lambdal region, or an improper union of the medial portion of the lambdoidal and postero-inferior part of the sagittal suture in the region of the posterior fontanelle. Here, in the superior and the posterior parts of the deepest portion of the intracranial cavity (in the interparietal parts of the occipital bone above the grooves for the lateral sinus), the osseous tissues are distorted and flattened. In certain places this condition is so pronounced, that in some situations the cerebral fossa are almost annihilated, and the inmost portion of the elevation of the superior longitudinal sinus and falx cerebri is increased. The most marked ocular signs are almost wholly sensory in character. Vision in each eye is nearly or entirely lost. The orbits are shallow, particularly at their postero-mesial parts. The eyeballs are but slightly proptosed, somewhat enlarged, and enjoy full freedom of movement. The motor apparatus of the exterior of the eyes, with the exception of a few minor discrepancies of probable improper nuclear action, is in good working

order. The pupils are but slightly, if at all, oversized. The irides are prompt to light-stimulus, efforts for accommodation, and convergence. The ciliary muscles are active. The eye-grounds, in every detail of neuronic, vascular, and lymph structure, appear normal; in fact, the eyeballs, with their entire adnexa, are healthy and perform their functional duties properly.

This complexus of symptoms, with its absolute blindness and concomitants of slight globular protrusion, divergence and the rotary nystagmus as the only ocular signs, constitute a most remarkable clinical picture. In it is seen a blindness, the proving of which necessitates a careful study of every possible direct and indirect ocular detail; a blindness that, from the ocular signs and associated conditions, may be assumed as intracranial in type, and most probable, until autopsy proves to the contrary, mainly cortical in character.

The accompanying reproduction of a photograph (Plate XX, Fig. 3) of a case recently studied by me and described in full elsewhere,[1] gives an excellent idea of the cranial deformation and the peculiar facial appearances and expression in an American-born type of case of this character. In this child the optical and receiving portions of the visual apparatus were apparently perfect. No visual perception, however, could be evolved in this case, no matter how centrally the impression reached (surely in this case back to the midbrain). Cortex sensation was lost; the discharging station was functionless.[2]

The cases thus far described exhibit but little, if any, mental involvement. The grossest of the resultant disturbances are mainly basilar in character, and in measure affect the vascular channels, the lymph cavities and the coarse nerve fibrils as they pass through both the primary and the secondary foramina. Trophic ocular disorder soon takes place; ophthalmic irritation signs and palsies early appear; sensory changes in the organs of vision quickly ensue; and, sooner or later, the main portions of the receiving, transmitting and discharging parts of the visual apparatus degenerate and become useless. Should the main distortions be situated in the anterior and central portions of the cranial base, producing antero-midbrain disorder, as in the first illustrative case, the more frequently in-

[1] The *American Journal of the Medical Sciences*, January, 1902.

[2] It is probable that cases of the badly termed condition "amaurotic famliy idiocy," with their peculiar lesions in the fundus of each eye, have some such similar origin.

volved become the ocular end organs. In this type the most bizarre motor ophthalmic signs are commingled in complicated yet definitely determinate interrelationships. On the contrary, the further back the coarse osseous changes are found, the greater become the sensory deficiencies of the visual apparatus and the better preserved remain the organs of vision and their contiguous parts.

In the anterior types the main basal cause of the condition may be summed as a series of asymmetries of basilar structures, with coarse anomalies in the various portions of the underlying sphenoidal and contiguous bones.

In the posterior types histological examination reveals cortex and nuclear changes in the posterior part of the sensory portions of the visual apparatus. In some such individuals the cellular elements may have attained a good size, and may have been able to function most excellently during early postnatal life. This can be understood when it is realized that nearly ninety per cent. of the gross volume of the brain mass is obtained during the first stage of postnatal existence; later, the association fibres and the neural cells continue to be the main factors of growth. This development, of course, exerts its influence upon the formative processes taking place in the osseous cranium.

In the majority of cases of these types there is a true tissue-sclerosis.

In deformation of the cranium occurring at a very early antenatal stage, the visual apparatus is more liable to become affected than any of the other special sense organs. On the contrary, morbific causes which affect the same apparatus during the later stages of development of the skull and its contents are not so apt to affect the organs of vision. It may be also of interest to state that the sensory portion of the visual apparatus being developed much earlier than the motor, and not possessing so many separations and ramifications in midbrain, is better able to withstand coarse pathological changes than the latter. Statistics and personal observations, however, have determined that the great majority of congenitally blind subjects possess malformations of the skull and its appendicular elements.

Far different are the grosser forms of more generalized cranial deformation, such as the two great classes, microcephales and macrocephales. Coarser disturbances of sensation, grosser peculiarities of motion, and increased degrees of trophic condition affect other

situations more markedly than they do the visual apparatus. Such cases always present mental inefficiencies and disturbances from either gross organic change or deficient development and growth in the intracranially placed tissues. Circulation of but small quantities of blood and lymph of poorly nourishing quality through the distorted and ofttimes inflamed and even contracted tissues, is seen in so many cases of this coarse type of disease, that it seems no wonder that cerebral development and growth soon become affected. Many such subjects are fortunately early victims of convulsive seizure, mental hebetude, general wasting from ectogenous infection, and death.

The cerebral alterations in these types are many. Should the case exhibit mental deficiency, the convolutions are generally gross, narrow and uncomplicated, while the related gyri are small and badly developed. Fissural confluences may be present, and not infrequently the occipital lobes do not extend over the usually too large cerebellum. These conditions are probably also found in other forms of genetous idiocy with and without eye lesions.

Some cases of that rare condition, microcephales, from too early ossification of the cranial sutures with and without idiocy, may have true microphthalmus as a part of the products of the same morbid cause; though functioning power, particularly that for color-perception, as far as can be scientifically determined, may, even in minor cases, remain practically undisturbed. As a rule, the eyeballs of such subjects are relatively well placed, and exterior ocular muscle action seems good.

In hydrocephales, on the contrary, there are frequent disturbances of muscle action in and around the eyeball, particularly during attempted movements of coördination, and when the parts are brought into association with the related ocular reflexes.

An extremely broad interpupillary distance with a broadening of the zygomatic arches forms one of the characteristic ophthalmic features of congenital cretins, whether they be endemic or sporadic in origin. In this peculiar type of cases sight is generally undisturbed, the sensory part of the visual apparatus usually being good. The visual organs, however, are somewhat differently sized. In such cases disturbances with the motor portions of the visual apparatus are quite common. The affected individuals are frequently deficient in hearing and are often unable to enunciate. The size of the orbits in these cases is unequal. The osseous irregularities,

however, are greater at the base of the skull. There is always a marked tendency to cranial asymmetry, the most pronounced abnormality consisting in a premature ossification of the sphenobasilar bones. In these cases the distance from the glabellar point to the occipital foramen is said by some to be quite short; by others this shortening is denied. Curiously, such subjects are said to never shed tears. Investigations, however, especially as to the condition of the secretory apparatus in these cases, should be made before any such dogmatic assertion as this can be hazarded.

It must be remembered that this communication does not deal with monstrosities such as cyclocephales, in which it is stated there is a circumscribed impairment of development and growth from mechanical pressure, exerted in some instances by the amniotic hood, an increase of intracranial pressure, resulting in rupture of the early cerebral vesicle, or an arrested development of the anterior vesicle as one of the results of anomalies in the amnion. This form of malformation presents several varieties. The first type of a true cyclopic monstere is that exhibiting the rhinocephalic malformation. Such an individual is represented by a head containing two more or less completely fused rudimentary eyes in a single orbit, the nose consisting in a proboscis situated above the orbit When there is a complete fusion of the orbital cavities and eyeballs without the vestige of a nose or a proboscis, the variety receives the designative term of cyclocephalus. Should the lower part of the face be additionally affected and the integument overlying the imperfectly developed superior and inferior maxillary bones hang in folds, the condition is known as stomacephalus.[1]

The artificial deformation of the skull of the infant in all manner of fantastical ways, which has been practiced by many tribes throughout the world before even the time of Hippocrates, is interesting in the fact that although of necessity the three great portions of the combined visual apparatus—the receiving, the transmitting and the discharging—must in every instance have been more or less pressed upon and distorted, yet probably by reason of the distortion

[1] These type-forms do not strictly include the nose-headed or ethmocephalic form of monster, in which there are two eyes and two orbital cavities, the nose being represented by a proboscis that is provided with either one or two nostrils. Neither do they include the monkey-headed or cebocephalic variety, in which there are two orbital cavities and two eyeballs, but not any nose, the intraocular region being both narrow and flat.

having been gradually accomplished after birth, gross bulbar disturbance, blindness, faulty muscle action, and coarse atrophic disorder have not been produced, and hence remain unmentioned as ordinary consequences in such cases.

Blindness from deprivation (postnatal causes), as in the wide-world known case of Laura Bridgman, which on autopsy was found to be associated with optic nerve and optic tract atrophy and thinning of the gray matter of the occipital cortex, is also a subject for discussion elsewhere.

ON THE CONTINUITY OF PROTOPLASM.

BY HENRY KRAEMER, PH.D.

(Plates XXI and XXII.)

(*Read April 4, 1902.*)

While Schleiden[1] conceived each cell to have an independent existence, Hofmeister[2] contended that the protoplasts of contiguous cells are united, forming a higher unity; that is, one synplast. In later years both Sachs[3] and Strasburger[4] have supported the view of Hofmeister. And even so great an authority as Nägeli[5] expressed the view that neighboring plant cells are united by means of threads of protoplasm in much the same manner as in the sieve tubes first described by Hartig[6] some thirty years before.

In 1878 Thuret and Bornet[7] first called attention to the fact that in certain of the Florideæ the contents of certain of the cells of the trichophore and carpogonium are directly connected by means of pores. Fromann[8] appears first to have called attention to the direct connection of protoplasm in the higher plants, in the epidermal and parenchyma cells in the leaves of Rhododendron and Dracena. While Tangl[9] was preceded by these several investigators, the establishment of the view that there is a continuity of protoplasm is due for the most part to his researches. On treating dry sections of the endosperm of *Strychnos Nux vomica* with dilute iodine solutions, he observed a distinct lamellation of the cell wall as well as the formation of yellowish striæ, which latter he conceived to be plasma threads connecting the different cells. The appearance thus produced he compares to the structure of the sieve tubes, but in speaking of the contents of the latter, he states that